1-1-2007

Deep Mixing Method for Ground Improvement

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DOI: 10.5703/1288284315792

EMERGING CONSTRUCTION TECHNOLOGIES

Civil - Foundation

DEEP MIXING METHOD FOR GROUND IMPROVEMENT

THE NEED

Many causes including presence of peats and highly organic soils in construction projects increase the risk of foundation failure or inadmissible settlements due to low strengths, high compressibility, prolonged creep, and low permeability. As a result, foundations, embankments, excavations, and other ground works become very difficult and often require costly treatments. Possible solutions to this kind of problems include 1) strengthening foundations; 2) removing the problem soils; 3) treating the problem soils; 4) relocating the project. However, these existing options are often considered impractical or too expensive.

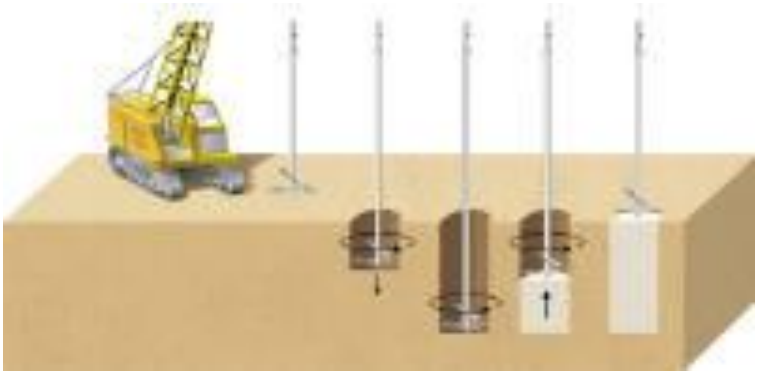

FIGURE 1 DEEP MIXING PROCESS - WRE METHOD (COURTESY OF HAYWARD BAKER)

THE TECHNOLOGY

The Deep Mixing Method (DMM), also known in parts of the U.S. as soil mixing, is an in situ soil treatment and improvement technology mechanically blending the in situ soil with cementitious materials that are referred to as binders using a hollow stem auger and paddle arrangement. The intent of the soil mixing method is to achieve improved soil properties. The cemented material that is produced generally has a higher strength, lower permeability, and lower compressibility than the native ground, although total unit weight may be less. The properties obtained reflect the characteristics of the native soil, the mixing method, and the binder characteristics (Bruce and Bruce 2003). Deep mixing technologies are usually categorized into "wet" mixing method and "dry" mixing method depending on how the binder is applied to the soil. In the wet mix method, a cementitious slurry is injected through large diameter to a specified depth. The

http://dx.doi.org/10.5703/1288284315792

common dry mix method is to rotate a mixing tool into the soil to break up the soil on the down stroke, and the dry reagent (quick lime or cement or a mixture of both) is pneumatically injected and blended with the soil by the mixing tool on the up stroke.

FIGURE 2 EXAMPLE OF MIXED COLUMN

The dry mix method is generally considered less expensive than the wet mix method. However, the strength of the final product is also considered less than the strength achieved for the same material with wet mix methods (Sheills et al. 2003).

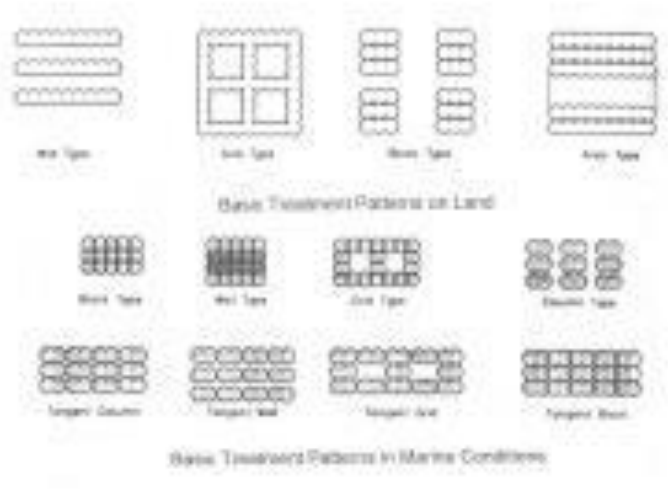

FIGURE 3 BASIC TREATMENT PATTERNS (BRUCE 2003)

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DMM can treat a wide range of soil types, and the compressive strengths are usually developed between 10 psi and 500 psi. The treatments and results vary depending on native soil characters and reagent binder contents. The application areas are as follows (Al-Tabbaa 2002):

- Groundwater control
- Excavation support
- Soil and foundation stabilization
- Liquefaction mitigation
- Vibration reduction
- Fixation of contaminants
- Passive and reactive in-ground barriers
- Repair of defective soil-bentonite cut-off walls

The Benefits

- Low vibration and noise during construction
- Applicability on various soil conditions; especially very effective in sensitive clay
- Reduction of project duration
- Various functions: ground improvement of a site, foundations, or retaining walls, etc.
- Reduction of off-site disposal problems

Status

Current practice is broadly based around Japanese and Scandinavian efforts dating from the late 1960s. In the United States, the works at Jackson Lake Dam, WY (late 1980s), Logan Airport, Boston, MA (early 1990s), and Fort Point channel, Boston, MA (late 1990s) have generated widespread industry interest and have established DMM as a technique of substantial technical merit and economic attractiveness, in favorable conditions.

Barriers

- Inexperience.
- Variable definition of verification and QA/QC.
- "Cost of entry" by contractors.

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Reviewers

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Publisher

Emerging Construction Technologies, Division of Construction Engineering and Management, Purdue University, West Lafayette, Indiana

http://dx.doi.org/10.5703/1288284315792